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John C. Schread

Mites are usually found wherever insects occur, and because of their small size are often mistaken for them.[1,2] They may, however, be distinguished from insects by the absence of discernible body segmentation and the presence of eight, rather than the six legs, which characterize insects. Young mites resemble the adults except that the newly hatched ones have six legs instead of eight. The size of mites varies from the size of a pin point to that of the head of a common pin, and they are classified in the same group with spiders and ticks.

The injury which mites cause to plants is quite like that done by piercing insects. It results from sucking the juices from the leaves and other tender parts of infested plants. Infested foliage becomes mottled or paled and may ultimately turn brown and drop prematurely. Some species of mites produce a fine webbing which becomes more noticeable as the population increases. The webbing is often more conspicuous on the undersides of the leaves, and is used by the mites to get from one area of a leaf to another. In some cases where the mites themselves cannot be seen, their presence is indicated by transparent cast skins and empty egg shells.[3] Most of the injury caused by mites occurs during warm, dry seasons when, because of favorable weather conditions, many generations develop.

The economic importance of certain species of mites has been recognized for a long time. Some species are plant pests; others are parasites of man and animals. The significance of mites as primary pests of vegetation has increased alarmingly in recent years. The phenomenon may to some extent be attributed to the use of certain insecticides developed during the last decade or so. These materials are highly efficient in the control of insects, but may indirectly result in increase in mites. DDT appears to be conspicuous among the chemicals responsible for this situation. The use of this insecticide to control both chewing and sucking insects has sometimes resulted in the destruction of the natural enemies of mites. Under most conditions when insecticides are not used or are used infrequently, the natural enemies of phytophagus mites tend to hold them at low population levels.

EARLIER METHODS OF CONTROL[4]

Before the development of the newer acaricides, a number of helpful remedies for the control of mites were employed. Frequent syringing or spraying of plants with water helped to keep mites at a low popula-

[1]All mite species listed in this bulletin were identified by Dr. P. Garman, Entomology Department, The Connecticut Agricultural Experiment Station.

[2]Photographs were taken by Mr. B. W. McFarland, The Connecticut Agricultural Experiment Station.

[3]Weigle, C. A. and L. G. Baumhofer. 1948. Handbook on Insect Enemies of Flowers and Shrubs. U.S.D.A. Miscellaneous Pub. 626: 1-115.

[4]Metcalf, C. L. and W. P. Flint. 1951. Destructive and Useful Insects. 3rd Edition. McGraw-Hill Book Company.

tion level in the greenhouse. This practice could not, however, be followed universally because of the injury caused to some plants by foliage watering. Furthermore, the procedure favored the development of disease. Spraying or dusting with parathion or tetraethyl pyrophosphate has given good results. The use of these materials in aerosols in greenhouses has also given good control.

Sodium selenate used as a dust or spray on the soil in greenhouse benches has been widely used. Rotenone applied to mite-infested plants as a spray or dust has met with universal success, especially in control of two-spotted spider mites. White oil emulsion, thiocyanate sprays and dusting sulfur have been effective both in the greenhouse and out-of-doors during the summer. Dormant oils and lime-sulfur give good control of overwintering mite eggs.

Destroying all litter in the garden during the autumn or in early spring before overwintering mites become active has helped to prevent spread of the pests to growing plants. Moreover, the prevention of weed growth during the spring and summer aids immeasurably in keeping mites away from valuable evergreens, shrubs and flowers.

In view of the probability that continued and widespread use of insecticides may be expected, the necessity for information concerning the control of mites on plants becomes urgent. For this reason the following discussion of the control of several species of mites has been prepared.

EXPERIMENTAL MATERIALS AND METHODS

The experiments were carried on from 1951 to 1954 inclusive. Insecticides and miticides used were of several types as follows:

EPN	O-ethyl O-*p*-nitrophenylbenzenethiophosphonate
Potasan	4-methylumbelliferone O, O-diethyl thiophosphate
Malathion	O, O-dimethyl-S-(1,2-dicarboxyethyl) dithiophosphate
Am. Cyanamid 12008	O, O-diethyl S-isopropylmercapto-methyl dithiophosphate
Am. Cyanamid 12009	O, O-diethyl S-*n*-propylmercapto-methyl dithiophosphate
Am. Cyanamid 12013	O, O-diisopropyl S-isopropylmercapto-methyl dithiophosphate
Systox	mixture of O, O-diethyl-S-ethlymercaptoethyl thiophosphate and O, O-diethyl-O-ethylmercaptoethyl thiophosphate
Aramite	Product containing 2-(*p*-tert-butylphenoxy) isopropyl-1-methylethyl 2-chloroethyl-sulfite
Dimite	di(*p*-chlorophenyl) methylcarbinol
Ovotran	Product containing *p*-chlorophenyl *p*-chlorobenzenesulfonate
Chem-Mite	*p*-chlorophenyl, *p*-chlorobenzene sulphenone
Chlorobenzilate	ethyl 4,4′-dichlorobenzilate
Isolan	dimethyl 5-(1-isopropyl-3-methylpyrazolyl) carbamate
Triton B-1956	was sometimes used as an additional spreading and sticking agent.

Experimental treatments were made on plants growing in nursery rows and also under greenhouse conditions. It was often more satisfactory to use small plants in greenhouse benches or in pots than larger ones in the field.

Field treatments were made by means of a 300-gallon hydraulic sprayer, a 12-quart wheelbarrow mist blower, a 30-gallon portable mist blower transported in a pickup truck, and a 100-pound capacity trailer-mounted

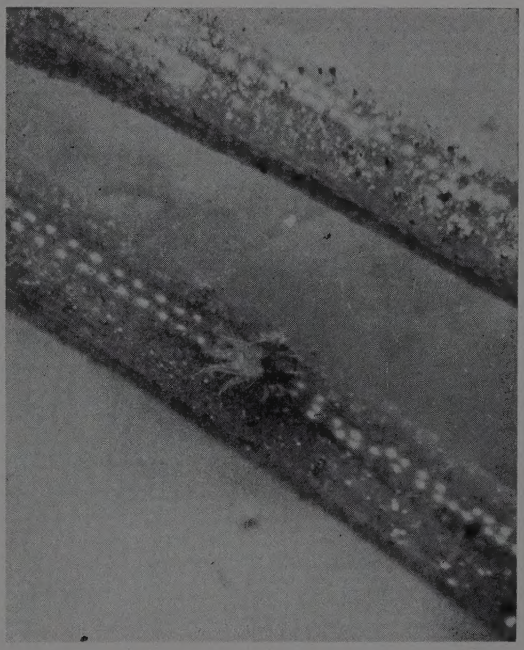

Figure 1. Adult spruce mite on spruce needle.

duster. In addition, a 3-gallon hand-operated pressure sprayer and a hand-operated duster were used to apply materials to a restricted number of plants where larger equipment could not be used. Applications of materials to plants growing in greenhouses were made with 1-quart and 3-gallon hand pressure sprayers. In certain instances small potted plants were dipped. When systemics were used, treatments were made as soil drenches.

SPRUCE MITE ON HEMLOCK

The spruce mite *Paratetranychus ununguis* is a perennial pest of spruce trees, especially blue spruce. In addition, hemlock, pine, and arborvitae may be seriously injured by the mite. Affected trees acquire an overall rusty and unthrifty appearance which is due to the sucking of the juices by the mites. The older needles may be the first to be attacked,

soon turning brown or yellowish and frequently dropping prematurely. Injury may first be noticeable on the branches on the lower parts of a tree, spreading progressively towards the top as the season advances. Outbreaks are usually more serious during the spring and early fall than in midsummer. Hot, dry seasons favor the mite. Young newly transplanted trees may die in a season whereas older trees will live for several years before deterioration is complete.

The adult mite (Figure 1) has a dark green abdomen, sometimes almost black with a pale streak on the back.[1] The eggs (Figure 2) are brown, and the young are uniformly flesh-color. Winter is passed in the egg stage at the base of the needles. Several or more generations develop from the spring through early autumn.

Figure 2. Nymphs, eggs, and empty egg shells of the spruce mite. Greatly magnified here, the eggs are actually about 20 mm. in diameter.

Control Experiments

Some of the early work done on the control of spruce mite[2] with Aramite, Bladex, EPN 300 and parathion showed these materials to be effective for the purpose. In the following experiments these and several additional acaricides were compared.

The first experiment on control of spruce mite was conducted in 1951 on a 120-foot hemlock hedge containing 42 trees sheared annually to a height of 4 to 5 feet and a width of 50 to 60 inches. Thirty of the trees were badly infested with mites. They were the only ones used for test treatments. Counts before treatments, May 10, indicated an average of 57.5 young mites and 122 eggs per two 2-inch hemlock twigs. No adult mites were found at this time. Aramite 30%, Dimite 25%, Ovotran 20%, and potasan 30% emulsions were used in dosage series of 1 to 200, 1 to 400, and 1 to 800. EPN 300, 27% wettable powder, was used at the rate of 1, 2, and 4 pounds per 100 gallons of water. A 12-gallon wheelbarrow mist blower was employed to make the treatment. Spray applications were made at the rate of 2 quarts of dilution per tree. Data on

[1]Garman, Philip, 1940. Tetranychidae of Connecticut. Conn. Agri. Expt. Sta. Bul. 431:20.
[2]Schread, John C. 1951. Spruce Mite Control. Conn. Agri. Expt. Sta. Circ. 180:11

control were obtained by counting all of the mites and eggs on 3 to 5 twigs averaging 3 inches in length, taken at random from the current season's growth.

Results of the treatments indicated that all five miticides gave good control of the spruce mite. Mite population counts made on May 22, June 1, 14 and 25, and July 5 and 23 showed that the hemlock trees treated with each dilution of the miticides tested were free from mite infestation. At the same time, however, the untreated trees were seriously infested (Table 1).

TABLE 1. SPRUCE MITE POPULATIONS ON UNTREATED HEMLOCK TREES

Data taken	Mite counts on three 3″ twigs	
	Eggs	Mites[1]
May 22	311	28
June 1	500+	200+[2]
14	422	69
25	53	51
July 5	143	64
23	17	0

[1]Young and adults included in this count.
[2]Adults only; young were not present.

An examination of Table 1 indicates a reduction in mite infestation on the untreated hemlocks from late spring onward. This was more noticeable after mid-June. The decline continued after early July until mites could no longer be found.

Infestation did not recur until mid-September, at which time 13 eggs and 35 mites (about equally divided between adults and young) were counted on eight 1-inch twigs taken from unsprayed trees. On this date mites were beginning to appear again on the treated trees; they were most noticeable on those sprayed with Aramite and EPN 300.

SPRUCE MITE ON NORWAY SPRUCE

Eight 30 to 35-foot Norway spruce trees badly infested with spruce mite were used in a control experiment during the spring and summer of 1951. Ovotran 25% wettable powder was applied to the trees on May 18, in dosage series of 1, 2, and 4 pounds per 100 gallons of water. A 300-gallon sprayer regulated at 400 pounds pressure was used to make the treatments. There were two trees in each treatment and two in the untreated checks. About 25 gallons of spray were used per tree. Data on control were obtained from an average of six 5 to 6-inch twigs taken at random from each treatment and the unsprayed trees (Table 2).

An examination of Table 2 indicates the effectiveness of Ovotran in controlling spruce mite on large Norway spruce trees at the height of infestation during the latter part of the spring. Because of the toxicity of Ovotran to mite eggs, they were counted on the untreated check trees only. Only fresh eggs were included in the count. The pattern of spruce mite decline from late spring through the summer months as indicated in a study of the species on hemlock appeared to be the same on spruce.

TABLE 2. MITE CONTROL ON SPRUCE TREES TREATED MAY 18, 1951

Treatment	Dilutions per 100 gallons	Mite infestation - av. per 6 twigs							
		May 23		June 5		June 20		July 5	
		Eggs	Mites[1]	Eggs	Mites[1]	Eggs	Mites[1]	Eggs	Mites[1]
Ovotran 25% wettable powder	1 lb.	0	2.5	0	0	0	0	0	.16
	2 lb.	0	0.3	0	.25	0	0	0	3.0
	4 lb.	0	0	0	0	0	0	0	0.0
Untreated checks		76.1	83.0	9.5	56.7	6.1	4.1	3.1	9.2

[1]Young and adults included.

SPRUCE MITE ON ARBORVITAE

For some time spruce mite on arborvitae has been a major problem in nurseries, as well as on private property and around public buildings where the plants are grown individually or collectively as, for example, in hedges. Hence, several experiments using various miticides to control the pest on arborvitae were undertaken. The first trials were run in 1952 using fourteen 3½ to 4-foot pyramid arborvitae (American variety) for the tests. Counts of mites after treatments were made on an average of five 3-inch twig samples of the current season's growth taken at random. Pretreatment counts indicated a total of 189 adult spruce mites on eight 2-inch twigs. Randomized treatments were made by means of a 12-quart wheelbarrow mist blower. Because of the limited number of trees available for experimental use, replications could not be followed. One to two quarts of spray material were used per tree (Table 3).

TABLE 3. CONTROL OF SPRUCE MITE ON ARBORVITAE TREATED JUNE 18, 1952

Material	Rate of treatment	No. adult mites on five 3" samples			
		July 9	July 17	July 24	Aug. 5
Ovotran 25% emulsion	1 - 100	0	0	0	0
	1 - 200	0	0	2	0
	1 - 400	0	0	1	0
	1 - 800	0	0	0	0
Dimite 25% emulsion	1 - 100	0	0	0	6
	1 - 200	0	0	3	16
	1 - 400	0	0	4	45
	1 - 800	0	1	7	57
Chem-Mite 80% emulsion	1 - 100	0	0	0	0
	1 - 200	0	0	6	0
	1 - 400	0	0	4	0
	1 - 800	0	0	2	81
Untreated checks		5	165	83	31

An examination of Table 3 will indicate the effectiveness of Ovotran, Chem-Mite and Dimite in controlling spruce mite on arborvitae. It appears, however, that Dimite at all dilutions did not hold up as well as the other materials and consequently did not prevent recurrence of mites after one month. This was somewhat noticeable with the Chem-Mite treatments five weeks later. From there on, however, the condition was much less obvious on the Chem-Mite-treated trees except at the lowest concentration, whereas the mite population on the Dimite-sprayed trees showed a decided increase.

In 1953, one-quarter acre of 3 to 4-foot pyramid arborvitae nursery stock infested with spruce mite was treated on June 18 with Ovotran 5% dust at the rate of 25 to 30 pounds to the acre. The treatment was made by means of a 100-pound capacity trailer-mounted duster. All data, including counts taken before the dust treatment was made, were obtained from ten 2½-inch arborvitae twigs sheared at random from the periphery of the dusted trees. Counts before treatment indicated a total of 42 mites and 756 eggs present per 10 twigs. Control data taken on June 24 (six days after treatment) showed good results. No live mites or eggs were found. The twigs taken from the untreated checks contained 32 live mites and 489 eggs. Ovotran dust did not injure the arborvitae.

Twenty-four globe arborvitae seriously infested with spruce mite were used in an experiment begun on July 6, 1954. The trees were 36 to 42 inches high with circumferences varying from 7 to 10 feet. Malathion 50%, Aramite 30%, Ovotran 25%, chlorobenzilate 25%, and Chem-Mite 80.7% emulsions were applied to the trees in dosage series of 1 to 400 and 1 to 800. Treatments were made by means of a 12-quart wheelbarrow mist blower using 1 gallon of spray per plant. All dilutions of the miticides were randomized and replicated once.

Data on control were secured on July 23 and August 3 and 16. Counts were obtained from six 3-inch twigs taken at random from the sprayed and unsprayed trees. The results indicated a drop of mite population from a pretreatment estimate averaging more than 250 mites per twig to none each time the counts were made. At the same time, however, the untreated checks had an average of 0, 1, and 7 mites per sample. Obviously the treatments were made at about the time the mites were beginning their annual population drop during the summer months. Check counts indicated that the mites were coming back on the untreated trees towards the end of August. This was not the case, however, in the treated ones. Decline in mites on the untreated check trees did not occur quite so early on arborvitae in 1954 as on hemlock and spruce in 1951. This may have been due to seasonal conditions.

GALL MITE

The group of mites to which the gall mite *Eriophyes thuje* (sometimes called blister mite, rust mite and bud mite) belongs are said to be the smallest plant feeders with external skeletons that damage agricultural

crops.[1] Most of the mites belonging to the family produce gall formations. There are, however, a number of free-living forms of which *E. thuje* is one.

This gall mite is very tiny and for the most part may go unnoticed by the human eye unless a hand-lens is used. The species has been found on hemlock and juniper in Connecticut and was first reported on American arborvitae by Garman in 1882.[2] The mite overwinters in the buds and under the edges of the leaves. As the weather grows mild in early spring, the mites begin to crawl out onto the leaves. They are whitish, semi-transparent, fleshy and longer than broad. The greatest diameter is through the anterior part of the body from which area the mite tapers to the end of the abdomen. The eggs are spherical, translucent, and extremely small. They may be seen only with great difficulty unless a microscope or hand-lens is used.

At first, badly injured hemlock needles display a mottling or blanching which soon changes to rust-like discoloration. When the damage is allowed to continue, the entire plant takes on a decidedly dark grayish-bronze to rust-like color. The persistence of infestation results in devitalized, unhealthy plants. Considerable dieback may result from loss of vigor after a season or two.

Experiments in the control of the gall mite were carried on during 1951. Eight 24 to 30-inch hemlocks, *Tsuga canadensis,* were removed from a mite-infested nursery block and planted in an area where no interference from surrounding plants could be expected.

On May 22 when the mite population appeared to be at its height, the trees were sprayed with several miticides in dosage series as indicated in Table 4. Treatments were made by means of a 3-gallon hand pressure sprayer. Each dilution was applied at the rate of 2 quarts per tree. Data on control were obtained from ten 3-inch (average) hemlock twigs taken at random from the current season's growth.

TABLE 4. CONTROL OF GALL MITE ON HEMLOCK TREATED MAY 22, 1951

Miticide	Dilution	No. mites per 10 twig samples May 29	
		Mites	Eggs
Aramite 30% emulsion	1 - 400	4	17
	1 - 800	9	13
Dimite 25% emulsion	1 - 400	2	50
	1 - 800	4	40
Ovotran 25% emulsion	1 - 400	0	25
	1 - 800	13	51
Untreated checks		113	556

[1]Keifer, H. H. 1946. A review of the North American Economic Eriophyid Mites. Jour. Econ. Ent. 39: 563-70.

[2]Forbes, S. A. 1883. Twelfth Report, State Entomologist, State of Illinois. (Report of Insects of Illinois): 154 pp.

Control of gall mite with the miticides used in the experiment is indicated in Table 4. With the exception of the Ovotran treatment at a dilution of 1 to 400, a few live mites were found on all of the sprayed trees. This perhaps could be expected because of the toxicity of Ovotran to mite eggs. On examination of the treatments on June 2, it was shown that the sprayed hemlocks were almost free from infestation. No mites and only a very few eggs were found on any of the plants. Untreated plants continued to be seriously infested. The treated trees remained about the same for the balance of the summer, whereas the untreated ones showed considerable decline in mite population from late spring until August 2, when infestation began to rise again with a count of 57 mites and 8 eggs per ten 3-inch twigs.

PRIVET MITE[1]

Although the privet mite *Brevipalpus inornatus* Banks occurs principally on privet (*Ligustrum amurense* and related species), it has also been reported as injurious to *Rumex acetosella, Oxalis stricta,* the garden mint (*Mentha spicata*), strawberry, Boston ivy, goldenrod (*Solidago* sp.), palm, *Phoenix humilis,* orange, and lemon. In the experiment reported here the mite occurred on *Azalea indica* and *A. hinodegiri* growing in a greenhouse. Because of its diversified host plants, it may be said that the species is a general feeder.

The adult mite is very small, averaging about 0.235 mm. in length. The body of the female is crimson with two eye-like markings on the cephalothorax. The male is much smaller than the female. Eggs are elliptical and always blood-red in color. They are usually deposited in close, compact masses with the long axis of an egg perpendicular to the leaf. Although the eggs may be deposited almost anywhere, they occur usually in crevices, cracks, or depressions. When such places are not present, they may be laid inside molted skins or in the grooves by the side of the mid-vein.

The mites feed mostly on the undersurface of the leaves. They do not create a pattern of small discolored feeding areas on azalea leaves, a condition so common to the injury caused by other species of mites, such as the spruce mite. Soon, however, under conditions of severe infestation, the injured leaves begin to turn yellow and ultimately become brown and drop from the plant. In a number of instances only the leaves on the lower part of an azalea plant were involved in heavy mite infestation. Consequently, these were the ones that were shed. In other cases, however, the older leaves on the entire plant were damaged sufficiently to turn yellow and drop. Plants thus injured lose their vitality quickly. A continued reduction in thriftiness may result in great weakness to the plant and ultimate death.

On February 11, 1952, three 12 to 14-inch *Azalea indica* plants growing in 8-inch pots in a greenhouse bench were treated with 25% Aramite emulsion in dosage series of 1 to 200, 400, and 800. In addition, 7 to

[1]McGregor, E. A. 1916. The Privet Mite in the South. Jour. Econ. Ent. Vol. 9: 556-561.

8-inch *Azalea hinodegiri* plants growing in 5-inch pots were treated with Dimite 25%, Ovotran 25%, Chem-Mite 80%, and Chlorobenzilate 25% emulsions in dosage series as indicated in Table 5. The sprays were applied by means of a 1-quart hand pressure sprayer using 4 to 6 ounces of miticide dilution per plant. Control data were obtained by counting all of the mites on 10 leaves taken at random from the sprayed and untreated check plants. Counts before treatments indicated a range of 42 to 236 eggs and from 1 to 50 mites on sixteen 10-leaf samples.

Good control of privet mite with the five miticides used in the experiment was indicated at all dilutions (Table 5). However, with the exception of the azaleas sprayed with chlorobenzilate, some of the plants treated with all of the other materials showed signs of reinfestation four weeks later.

On February 14, three days after the treatments were made, leaves began to fall from the plants sprayed with Dimite at all dilutions. This did not appear to be taking place on the azaleas treated with the other miticides. By the end of the month a high percentage of the leaves had been shed from the Dimite-treated plants. Consistent with earlier observations, none were dropping from the azaleas sprayed with Aramite, Ovotran, Chem-Mite and chlorobenzilate.

TABLE 5. PRIVET MITE CONTROL ON AZALEA TREATED FEB. 11, 1952

Miticide	Dilution	No. live mites per 10 leaves per treatment	
		February 18	March 10
Aramite 25%	1-200	0	0
	1-400	0	2
	1-800	0	0
Dimite 25%	1-200	0	1
	1-400	0	0
	1-800	0	0
Ovotran 25%	1-200	0	3
	1-400	0	3
	1-800	0	6
Chem-Mite 80%	1-200	0	0
	1-400	0	8
	1-800	1	0
Chlorobenzilate 25%	1-200	0	0
	1-400	0	0
	1-800	0	0
Untreated checks		10	11

TWO-SPOTTED SPIDER MITE

The two-spotted mite *Tetranychus bimaculatus* Harv. has been reported from a wide variety of host plants growing throughout the world. It is said that there are very few greenhouse plants that are not subject to injury by the species. In addition, certain ornamentals, flowers and weeds growing out-of-doors may be seriously damaged. Until recently

it was believed that almost any cultivated plant with perhaps conifers as an exception[1] could serve as host to the mite. Several years ago, however, the pest turned up on yews in nurseries in the Connecticut River Valley. Widespread damage ensued. Since then the species has been reported injuring various varieties of yews in widely scattered areas of the State. Besides yews, roses, carnations, snapdragons, chrysanthemums, cucumbers, tomatoes, arborvitae, cedars, hydrangeas, clematis, asparagus, and melons are a few of the plants and shrubs that may become infested by the two-spotted mite.

Figure 3. Right and left branches of this pyramid yew have been injured by the two-spotted mite. The center branch is uninjured.

Most of the injured plants present an abnormal appearance (Figure 3). Although the condition may be obvious, it is somewhat difficult to describe. On close examination the foliage will be found to be spotted with pale, blanched areas. Later the leaves may turn yellowish or reddish-brown in part or completely. Loss of vigor may result in the death of the plant. Mite-infested yews first show damage on the lower part of the plant, and usually on the warmer south-west side. An uncontrolled outbreak may spread rapidly throughout the plant, causing a twisting and gnarling of the tips of the current season's growth, which soon turns brown and dies.

The female mite varies from a pale flesh color or greenish color to a brilliant carmine with two dark spots above and darker areas on the sides. The male is smaller (1/80 of an inch long); otherwise it re-

[1]Garman, Philip 1940. Tetranychidae of Conn. Conn. Agri. Expt. Sta. Bul. 431: 20 pp.

sembles the female. Eggs are pearl-like or transparent. Adult mites overwinter under the bark scale of host plants growing in the open. In contrast to the lighter colors of the summer form, the hibernating mites are uniformly pink with no spots.[1]

Control Experiments

On August 11, 1952, twelve 36 to 42-inch pyramid yews badly infested with the two-spotted mite were dug from a nursery and planted alone at about 5-foot intervals in an area where there would be no interference from surrounding vegetation. The trees were then treated with 25% Ovotran and 25% chlorobenzilate emulsions at 1 to 800. In addition, Ovotran 50% wettable powder was used as a dust. The sprays were applied by means of a 3-gallon hand-operated pressure sprayer and the dust treatment was made by means of a 14-inch cylindrical hand duster. One to two quarts of spray were used per tree. The dust treatment was medium-light. The number of adult plus young mites before treatments were made averaged 24 per 3-inch twig taken at random from the current season's growth. Treatments were replicated three times.

An examination of the treatments on August 18 indicated no live mites present on any of the treated plants. The untreated plants had 6 to 38 live mites per 3-inch twigs. On September 9 there were no live mites on four 2 to 3-inch twigs taken at random from the treated yews. There were, however, 10 live mites on the four twigs taken from the unsprayed plants. No noticeable injury to the yews developed from either of the two miticides.

On February 19, 1953, 8 to 10-inch *Azalea hinodegiri* growing in 5½-inch pots in a greenhouse bench were dipped in 50% malathion at dilutions of 1 to 200, 1 to 400, and 1 to 800. The treatments were replicated twice. A count of live mites on 24 leaves taken at random from the azaleas before treatments were made indicated an average of 6.2 adults per leaf. Control data were obtained from 12 leaves per treatment (Table 6).

TABLE 6. CONTROL OF TWO-SPOTTED MITE OF AZALEA DIPPED FEBRUARY 19, 1953

Material	Dilution	No. mites per 12 leaves on Feb. 20	
		Dead	Live
Malathion 50% emulsion	1-200	51	0
	1-400	27	0
	1-800	97	0
Untreated		0	53

Control of two-spotted mite on azalea with malathion was complete at all dilutions (Table 6). The treatments did not injure the plants.

[1]Garman, Philip, and J. F. Townsend 1952. Control of Apple Insects. Conn. Agri. Expt. Sta. Bul. 552: 84 pp.

The 1954 experiment was intended as a control of gladioli thrip. Before the tests had progressed very far, however, the thrip infestation disappeared from both treated and untreated plants and the two-spotted mite had taken its place.

On January 15, twenty gladioli[1] corms per treatment were soaked in 25% Isolan and 50% 12008 emulsions at dilutions of 1 to 400 and 1 to 800 for 30 and 60 minutes respectively. As soon as the corms were removed from the dips, they were planted in 4-inch pots (4⅜ inches deep) with about 3 inches of soil covering each corm.

All of the corms grew in a normal manner in the greenhouse during the remainder of the winter. Many flowers were produced after April 1. None of the gladioli leaves or flowers produced by the treated and untreated corms showed signs of thrip injury.

Soon after the early part of March the two-spotted mite began to appear in the Isolan-treated series, and on the untreated checks. With the advent of spring an accelerated increase in mite population occurred, becoming more and more noticeable on the Isolan-treated plants and the checks. Only a few appeared on the foliage of the 12008-treated series. On June 3 counts were made of the number of mites on ten 4-inch gladioli leaf tips taken from each series of treatments (Table 7).

TABLE 7. CONTROL OF TWO-SPOTTED MITE ON GLADIOLI-TREATED JANUARY 15

Material	Dilution	No. live mites on ten 4"-leaf tips per treatment June 3 — Period of exposure in hours: ½	1
Isolan 25% emulsion	1-400	985	1104
	1-800	825	1226
12008 25% emulsion	1-400	129	89
	1-800	431	112
Untreated checks		2150	

Although the two-spotted mite was found on the foliage of all treated and untreated gladioli corms (Table 7), it becomes quite clear that the 12008-treated series were much freer from infestation than the checks and the Isolan-treated ones (Figure 4). No noticeable injury to gladioli corms, foliage or flowers could be seen from Isolan and 12008 used as dips for the corms.

THE TWO-SPOTTED MITE ON CARNATION

An experiment to control the two-spotted mite on carnation was undertaken on February 5, 1954. Three varieties of carnation, *Dianthus apollo*, *D. Wm. Sim*, and *D. caryophyllus*, were used in the trials. The plants

[1]Variety Valeria.

Figure 4. The gladiolus plant at right was treated with 12008 for control of the two-spotted mite. Plant at left was untreated.

were growing in 6-inch pots and averaged 2 to 2½ feet in height, with 3 to 5 stalks each. Systox, 12008, 12009, and 12013, 50% emulsions were used as soil drenches in dosage series of 1 to 800, 1 to 1600, and 1 to 3200 at the rate of 6 ounces per pot. Each pot was placed in an 8-inch pan filled to about one-half its 3-inch depth with washed sand. Because of the limited number of plants available for the tests, replication of treatments was not possible. Counts of the number of eggs and mites on six carnation leaves taken at random from the plants before treatment indicated a total of 396 eggs and 273 live mites (adults plus young) present. All control data were obtained by counting live mites within a range of 1 to 100 per leaf. Populations exceeding this number were estimated. All leaves examined for control counts were taken from the plants at a height of 6 to 8 inches above the soil (Table 8).

A study of the data in Table 8 indicates inconsistency among the systemics in controlling the two-spotted mite on carnation. Obviously in most instances the strongest dilutions gave best results with residual effectiveness sustained for perhaps a month. The exception to this occurred in the use of 12008 at 1 to 800. At this dosage level the material failed to achieve good control of mites even after a second treatment

TABLE 8. CONTROL OF TWO-SPOTTED MITE ON CARNATION TREATED FEBRUARY 5

Material	Dilution	No. live mites per 4 Leaves			
		Feb. 18	March 4	March 18	Apr. 20
Systox	1-800	0	13	42	550+
50% emulsion	1-1600	0	3	81	475+
	1-3200	29	90	213	500+
12008	1-800	99	98[1]	61	250
50% emulsion	1-1600	1	9	3	225
	1-3200	0	1	0	140
12009	1-800	3	8	2	18
50% emulsion	1-1600	94	0	0	5
	1-3200	5	111	81	250
12013	1-800	0	31	78	400+
50% emulsion	1-1600	0	31	100	500+
	1-3200	12	29	90	225
Untreated checks		339	42	52	400+

[1]Because of the poor showing by 12008 at 1 to 800, the treatment was repeated.

was made. Owing to the consistently good control with 12008 at the remaining two dilutions, it could be said that the less desirable results at the highest rate may have been due to a difference in the plant itself. Compound 12009 seemed to be somewhat slower in its action, but gave more lasting control for a longer period of time than the other miticides. The systemic 12013 seemed to lose its toxicity to mites more rapidly than the other materials. Systox did not hold up too well after four weeks.

THE SOUTHERN RED MITE

The southern red mite *Paratetranychus ilicis* McG. is reported as a pest of holly (*Ilex*), rose, sweet pepperbush, and camellia in Connecticut.[1] It is a conspicuous species because of its color pattern. The female abdomen is dark brown with the collar pinkish or reddish. The males resemble the females except that there may be no reddish coloration. The eggs are brown to reddish, whereas the young are whitish with some red dots.

The experiment reported here was carried on out-of-doors in early spring using 4-year-old Japanese holly *Ilex crenata rotundafolia* which were badly infested with southern red mite eggs. Plants averaging 12 to 15 inches in height were removed from a large block of plants and planted at 4-foot intervals in an area by themselves. Counts of the number of eggs per leaf before treatment (average 28.7) and also the number of mites after treatments were made on ten leaves taken at random from the 16 plants in the experiment. Material and dilutions are given in Table 9. Ten to twelve ounces of spray were used per plant applied by means of a 3-gallon hand pressure sprayer. Triton B-1956 was used at the rate of 1 to 1600, as an additional spreading and sticking agent.

[1]Garman, Philip 1940. Tetranychidae of Conn., Conn. Agri. Expt. Sta. Bul. 431: 21 pp.

TABLE 9. CONTROL OF SOUTHERN RED MITE ON HOLLY, TREATED MARCH 26

Material	Dilution	Total No. live mites & eggs per 10 leaves, May 26	
		Mites	Eggs
Ovotran 25% emulsion	1-200	0	0
	1-400	2	5
	1-800	6	7
Untreated checks		51	275+

Results of the treatments to control southern red mite eggs with Ovotran were good (Table 9). It would appear that a few eggs escaped the toxic effect of the miticide at the two lowest concentrations. This is evident by reason of the mild reinfestation which occurred during the second month after treatment.

CONCLUSIONS AND SUGGESTIONS FOR CONTROL

The foregoing discussion of the control of five species of mites attacking ornamentals indicates the effectiveness of 13 pesticides. Certain of the systemic materials appeared to be more toxic to mites than others; they also exhibited more extended residual activity. On the other hand, all of the specific miticides seemed to be equally effective in controlling the crawling stages of mites. Variations from this occurred only in the use of Ovotran and Chem-Mite, both of which were toxic to mite eggs.

Control of Mites on Plants Out-of-Doors

Aramite, Ovotran, Chem-Mite, chlorobenzilate, Dimite, and malathion emulsions used at the rate of 1 pint in 100 gallons of water (1 teaspoon per 1 gallon) will control the following species: the spruce mite on spruce, hemlock and arborvitae; the gall mite on hemlock; the privet mite and two-spotted mite on azaleas; the two-spotted mite on yew, and the southern red mite on holly. Wettable powders may be substituted for the emulsions at the rate of 1 to 2 pounds per 100 gallons of water (2 to 3 teaspoons per gallon). Certain of the miticides, such as Ovotran and malathion, will prove effective when used in low concentrate dust form. The systemic 12008 used at the rate of 1 to 2 pints per 100 gallons of water (1 to 2 teaspoons per gallon) as a dip for gladioli corms should give good control of the two-spotted mite.

To control spruce mite, treatments should be made in late April or early May and repeated if necessary at 2 to 4-week intervals until late June. Under most conditions treatments may then be discontinued until late summer or early autumn, when the program should be resumed if necessary.

Because of the overwintering habits of the adult, gall mite treatments should begin at the close of March (when the season is early), or not later than the first part of April. Several treatments at about 10 to

14-day intervals may be necessary for best results. Spraying or dusting in late September or early October may be quite helpful in reducing the number of overwintering gall mites.

Treatments to control southern red mite on holly, azalea or other plants infested by the species should be made during May with perhaps additional controls applied in late summer or early fall. Ovotran or Chem-Mite treatments made in early April before the eggs hatch should give good results.

Control of mites on azaleas growing out-of-doors should start in May, with one or more treatments made until early summer. Usually when the season has been hot and dry, retreatment in late summer is a must, especially when control measures were not undertaken earlier in the year.

Certain preventive measures may be followed in controlling the two-spotted mite. Weeds, grass and other undesirable vegetation should be reduced to a minimum in the vicinity of shrubs and evergreens such as yew, holly, and azalea. This will help to discourage migration of mites to the plants requiring protection.

Control of Mites on Greenhouse Plants

Systox and other systemic emulsions such as 12008, used as soil drenches at the rate of 1 pint per 100 gallons of water (1 teaspoon per gallon) and applied to the soil of potted plants at the rate of 1 ounce of solution to each inch of pot diameter (6 ounces per 6-inch pot), should give good control of the two-spotted mite on carnations. A booster treatment of one-half this dose 4 to 6 weeks later may be expected to give more lasting results. Carnations growing in benches may be treated by drenching the bench with similar dilutions.

Control of privet mite and two-spotted mite on greenhouse azaleas can be attained through the use of Aramite, Ovotran, Chem-Mite, Dimite, chlorobenzilate, and malathion used at the rate of 1 pint in 100 gallons of water (1 teaspoon per gallon). Wettable powders are sometimes substituted for emulsions at the rate of 1 to 2 pounds per 100 gallons of water, (2 to 3 teaspoons per gallon). Treatments may be necessary at any time during the year but most certainly during the spring and summer months when mite broods occur frequently and reinfestation is more apt to arise.

Obviously, successful control of all species of mites depends in large measure on well timed and thorough applications of miticides. When a treatment is delayed or made in a haphazard manner, some injury by mites may be expected. Consequently, the necessity for promptness and thoroughness in attacking a mite problem becomes essential.